

DIVISIONAL APPLICATION  
FOR  
UNITED STATES LETTERS PATENT

Entitled

INTEGRATED CIRCUIT CHIP PACKAGE

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integrated circuit chip within a cavity formed when the cover and the base section are bonded to provide the package.

5 With such a package, a low cost, electrically effective MMIC package is provided.

In one embodiment of the invention, the base section includes a dielectric member and in another embodiment the base section includes a dielectric member and a conductive member.

10 In accordance with another feature of the invention, a method for packaging an integrated circuit chip adapted to operate at microwave frequencies is provided. The method includes providing a lead frame having electrical leads extending outwardly from an inner region of the lead frame;  
15 affixing a base section to the lead frame with portions of the electrical leads extending outwardly from the base section and mounting the integrated circuit chip to the platform. Electrical wires are connected between the integrated circuit chip and the electrical leads. The base  
20 section and the cover are adhesively bonded with the integrated circuit chip and the electrical wires connected thereto disposed within a cavity formed by the affixed base section and cover.

25 With such method a relatively simple, low cost packaging technique is provided.

In accordance with another feature of the invention, a package for an integrated circuit chip adapted to operate at microwave frequencies is provided. The package includes an electrically conductive lead frame having electrical  
30 leads adapted for electrical connection to the integrated circuit. The base section includes an electrically conductive member and a dielectric member, such dielectric member having an aperture therein. The dielectric member

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aperture is disposed in registration with an inner region of the lead frame. An upper surface portion of the conductive member is adhesively bonded to a bottom surface portion of the dielectric member. Another upper surface portion of the conductive member is adapted for electrical connection to a bottom ground plane of the integrated circuit with such integrated circuit chip disposed in registration with the aperture. A plastic cover is adhesively affixed to upper portions of the lead frame and upper portions of the dielectric member, the plastic cover being configured to provide a cavity when the cover and the base section are affixed with the integrated circuit chip being disposed with such provided cavity and with a bottom surface portion of the conductive member being exposed exteriorly of the package to provide a ground plane connector for the bottom ground plane of the integrated circuit.

With such package, the bottom ground plane of the integrated circuit chip may be easily connected to the ground plane provided by the conductive member.

In accordance with another feature of the invention, a method is provided for packaging an integrated circuit chip adapted to operate at microwave frequencies. The method includes the steps of: providing a lead frame having electrical leads extending outwardly from an inner region of the lead frame; providing a base section having a conductive member and a dielectric member, the dielectric member having an aperture; connecting electrical wires between the integrated circuit chip and the electrical leads and a bottom ground plane of the integrated circuit chip to the electrically conductive member with the integrated circuit chip being in registration with the aperture; and, adhesively affixing the base section to a plastic cover to provide a package for the integrated circuit chip and the

electrical wires connected thereto within a cavity provided by adhesively affixed base section and dielectric cover with a portion of the electrically conductive member being exposed exteriorly of the package.

5 With such method the bottom surface of the integrated circuit chip may be easily grounded externally using a surface external to the package.

10 In accordance with still another feature of the invention, a package an integrated circuit chip adapted to operate at microwave frequencies is provided. The package includes: (a) a lead frame having electrical leads extending outwardly from an inner region of the lead frame; (b) a base section comprising: a dielectric member having an aperture and; an electrically conductive member having an upper  
15 surface adapted for electrical connection to a bottom ground plane of the integrated circuit chip when the integrated circuit chip is in registration with the aperture; and (c) a dielectric cover, such cover being configured to provide a cavity for the integrated circuit chip when the cover and  
20 the base section are affixed and to expose a bottom portion of the conductive member exteriorly of the package.

#### Brief Description of the Drawing

These and other advantages of the invention will become more readily apparent from the following detailed  
25 description taken together with the accompanying drawings, in which:

FIG. 1A is a cross-sectional elevation, diagrammatical sketch of a package for an integrated circuit adapted to operate at microwave frequencies;

30 FIG. 1B is a plan view of the package of FIG. 1A, the cross sectional view of FIG. 1A being taken along line 1A-1A of FIG. 1B;



a dielectric member of a base section of the package of FIG. 3A on an exemplary site of the lead frame of FIG. 4A, FIG. 4C being a cross-sectional elevation sketch showing the relationship between the dielectric member of the base section of the package of FIG. 3A on the exemplary site of the lead frame of FIG. 4A after the dielectric member and the lead frame have been adhesively affixed together, FIG. 4D being a cross-sectional elevation sketch showing the relationship between a conductive member of the base section of the package of FIG. 3A and the adhesively affixed dielectric member and lead frame of FIG. 4C; FIG. 4E being a cross-sectional elevation sketch showing the relationship between the conductive member of the base section of the package of FIG. 3A and the adhesively affixed dielectric member and lead frame of FIG. 4C after the two have been adhesively affixed together, and FIG. 4F being a cross-sectional elevation sketch showing the relationship between a cover of the package of FIG. 3A and the lead frame of FIG. 3A prior the to affixation therebetween.

#### 20                    Description of the Preferred Embodiments

Referring now to FIGS. 1A and 1B, a package 10 for an integrated circuit chip 12, here an MMIC, adapted to operate at microwave frequencies, is shown. The package 10 includes an electrically conductive lead frame 14 having electrical leads 16 extending outwardly from an inner region 18 thereof and a mounting platform 20 disposed with the inner region 18. The platform 20 has mounted to an upper surface portion thereof the integrated circuit chip 12, as shown.

30                    The package 10 also includes a base section 22, here a dielectric member 22<sub>1</sub>. Here dielectric member 22<sub>1</sub> is

plastic and is adhesively affixed by a B-stage epoxy 24 onto a bottom surface portion of the platform 20 and onto bottom portions of the electrical leads 16. A dielectric cover 26, here plastic, is adhesively affixed to the dielectric member 22<sub>1</sub> with a B-stage epoxy 28. The base section 22 and the cover 26 are configured to provide package 10 with an air-filled cavity 30 when the cover 26 and the base section 22 are affixed together with the integrated circuit chip 12 being encapsulated within the provided cavity 30, as shown.

As noted in FIGS. 1A and 1B, the cover 26 of package 10 has a recess disposed within sidewalls 32 and ends of the sidewalls 32 are affixed to the base section member 22 to encapsulate the integrated circuit chip 12 with the package 10. Here, the cover 26 and base section 22 are each separately formed using injection or transfer molding.

Referring now to FIGS. 2A through 2E, the method for forming the package 10 will be described. Thus, referring first to FIG. 2A the electrically conductive lead frame 14 is provided. The lead frame 14 has a plurality of sites 40 therein. Each site 40 has: electrical leads 16 extending outwardly from the inner region 18 of the site 40; and, the platform 20. The electrical leads 16 support the platform 20 to the frame 44 within the inner region 18 of the site 40, as shown.

Next, considering an exemplary one of the sites 40, and referring to FIGS. 2B and 2B', each one of a plurality of the dielectric members 22<sub>1</sub> is disposed over, and affixed to, a corresponding one of the sites 40 using epoxy 24, as shown. More particularly, the dielectric members 22<sub>1</sub> are affixed to the platform 20 and portions of the electrical leads 16. It is noted that the dielectric members 22<sub>1</sub> includes a recess, or ridge 23, having side walls 25. Such



configuration is provided to increase the surface tension 4  
between the applied B-stage epoxy 24 and the dielectric  
member 22<sub>1</sub>, thereby to prevent the liquid-like epoxy from  
dripping off of the dielectric member 22<sub>1</sub>.

5           Next, referring to FIGS. 2C and 2D, the lead frame  
14 and the dielectric members 22<sub>1</sub> are pressed together, as  
shown, and the structure is heated to cure the B-stage epoxy  
24. It is noted that the epoxy 24 is thus squeezed downward  
(i.e., compressed) by the force of the dielectric member  
10 22<sub>1</sub>; however, amount of compression is limited by the legs  
27 of ridge 23 formed in the dielectric member 22<sub>1</sub>. More  
particularly, the dielectric member 22<sub>1</sub><sup>13</sup> formed with the  
ridges 23 and sidewalls 25 by injection or transfer molding.  
It is also noted that portions 31 of the epoxy 24 are  
15 exposed and thereby enable visual observation of the curing  
process on a sample testing basis after the package has been  
opened.

20           Next, referring to FIG. 2E, the lead frame 14 with  
the attached dielectric members 22<sub>1</sub>, as shown in FIG. 2D,  
are turned over. Each one of a plurality of integrated  
circuit chips 12 adapted to operate at microwave frequencies  
is mounted to a corresponding one of the plurality of  
platforms 20, only one being shown at the exemplary one of  
the sites 40 in FIG. 2E. Next, electrical wires 48 are  
25 connected between the integrated circuit chips 12 at each  
one of the plurality of sites 40 and the electrical leads 16  
at the corresponding one of the sites 40.

30           Next, the covers 26 are affixed to upper portions of  
the electrical leads 16 and the dielectric member 22<sub>1</sub> with  
epoxy 28 to provide the package 10 shown in FIGS. 1A and 1B.  
Thus, the cover 26 and dielectric member 22<sub>1</sub> encapsulate  
each one of the integrated circuit chips 12 and the

How?

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Referring now to FIGS. 3A and 3B, an alternative integrated circuit chip package 10' is shown. Here, the integrated circuit chip package 10' includes an electrically conductive lead frame 14' having electrical leads 16 adapted for electrical connection to the integrated circuit chip 12. It is noted that the lead frame 14' does not have a platform such as platform 20 in FIGS. 1A and 1B. The base section 22' includes a dielectric member 22'<sub>1</sub> and a conductive member 22'<sub>2</sub>. The dielectric member 22'<sub>1</sub>, having a central aperture 60, is adhesively affixed with a B-stage epoxy 61 to bottom portions of the lead frame 14'. The conductive member 22'<sub>2</sub> is adhesively affixed to the bottom portions of the dielectric member 22'<sub>1</sub> with B-stage epoxy 65. The conductive member 22'<sub>2</sub> has an upper surface portion electrically connected to a bottom ground plane conductor 68 of the integrated circuit chip 12. The integrated circuit chip 12 is disposed in registration with the aperture 60. More particularly, a portion of the integrated circuit chip 12 is positioned with aperture 60, as shown.

The package 10' includes a dielectric cover 26', here plastic. The electrically conductive member 22'<sub>2</sub> with the attached dielectric 56 and the attached cover 26' are configured to provide an air-filled cavity 30' when the cover 26' and base section 22' are affixed together with the integrated circuit chip 12 being disposed with such provided cavity 30' and with a bottom surface portion 70 of the conductive member 22'<sub>2</sub> being exposed exteriorly of the package 10', as shown more clearly in FIG. 3A. Thus, the bottom portion 70 of the electrically conductive member 22'<sub>2</sub> provides a ground plane connector for the ground plane conductor 68 of the integrated circuit chip 12. Again wires

48 are electrically connected between the integrated circuit chip 12 and the electrical leads 16.

Referring now to FIGS. 4A through 4F, a method for forming the package 10' shown in FIGS. 3A and 3B will be described. Referring first to FIG. 4A, the lead frame 14' is provided having electrical leads 16 extending outwardly from an inner region 18 of the lead frame 14'.

Referring now to FIG. 4B, the plastic dielectric member 22', having the aperture 60 therein is provided. Here, the dielectric member 22', is injection or transfer molded with ridges 72, 73 having side walls 74, 75, respectively as shown. Such ridges 72, 73 are formed as described above in connection with FIG. 2F. Such configuration is provided to increase the surface tension between the applied B-stage epoxy 61 and the dielectric member 22', and B-stage epoxy 65 (FIG. 4D) and the dielectric member 22', thereby to prevent the liquid-like epoxy from dripping off of the dielectric member 22'. Next, and referring to FIGS. 4C, the dielectric member 22' and the lead frame 14' are pressed together, as shown, and the structure is heated to cure the B-stage epoxy 61. It is noted that the epoxy 61 is thus squeezed downward (i.e., compressed) by the force of the dielectric member 22'; however, amount of compression is limited by the ridges 72 formed in the dielectric member 22'. It is also noted that portions 75 of the epoxy 61 are exposed and thereby enable visual observation of the curing process adhesively affixed to the lead frame 14' by a B-stage epoxy 61. Again, the epoxy projects beyond the edge of the lead 14', as described above in connection with FIG. 2F.

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Referring now to FIG. 4D, the conductive member 22'<sub>2</sub> is provided. The conductive member 22'<sub>2</sub>, is here copper.

Next, and referring to FIGS. 4E, the dielectric member 22'<sub>2</sub> and the dielectric member 22'<sub>1</sub> are pressed together, as shown, to provide the base section 22' and the structure is heated to cure the B-stage epoxy 65. It is noted that the epoxy 65 is thus squeezed downward (i.e., compressed) by the force of the base section 22'; however, amount of compression is limited by the ridges 73 formed in the dielectric member 22'<sub>1</sub>. It is also noted that portions 83 (FIG. 4E) of the epoxy 65 are exposed and thereby enable visual observation of the curing process. The portion 83 projects as described above in connection with FIG. 2F.

Next, the lead frame 14' is turned over as shown in FIG. 4F. The ground plane conductor 68 of the integrated circuit chip 12 is affixed to the conductive member 22'<sub>2</sub> with a suitable conductive epoxy, not shown. Electrical wires 48 are connected between the integrated circuit chip 12 and the electrical leads 16. Next, the plastic cover 26' is provided. The plastic cover 26' is injection or transfer molded and is formed with a ridge 90 having sidewalls 92. The B-stage epoxy 29 is applied to the ridge 96, as shown. Such configuration is provided to increase the surface tension between the applied B-stage epoxy 29 and the lead frame 14' to prevent the liquid-like epoxy 29 from dripping off of the cover 26'. Next, and referring to FIGS. 3A and 3B, the cover 26' and lead frame 14' are pressed together, as shown, and the structure is heated to cure the B-stage epoxy 29. It is noted that the epoxy 29 is thus squeezed downward (i.e., compressed) by the force of the cover 26'; however, amount of compression is limited by the ridges 90 (FIG. 4F) formed in the cover 26'. It is also noted that portions 97 of the epoxy 29 are exposed and thereby enable visual observation of the curing process on a sample testing

basis after the package has been opened. It is also noted that when the cover 26' and base 22' are affixed to provide the package 10' for the integrated circuit chip 12, such integrated circuit chip 12 is disposed within the cavity 30' formed by the affixed base section 22' and cover 26' and with the bottom portion 70 of the electrically conductive member 22'<sub>2</sub> being exposed exteriorly of the package 10'.

Finally, the distal portions of the electrical leads 16 are severed from the frame 44 to provide the packaged integrated circuit chip 12 shown in FIGS. 3A and 3B.

Other embodiments are within the spirit and scope of the appended claims.

What is claimed is: